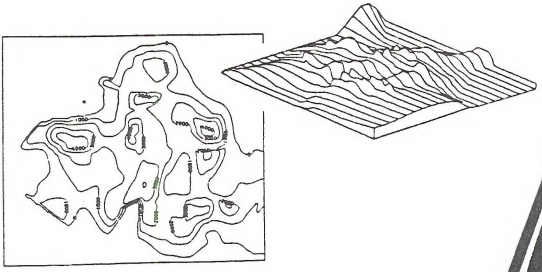
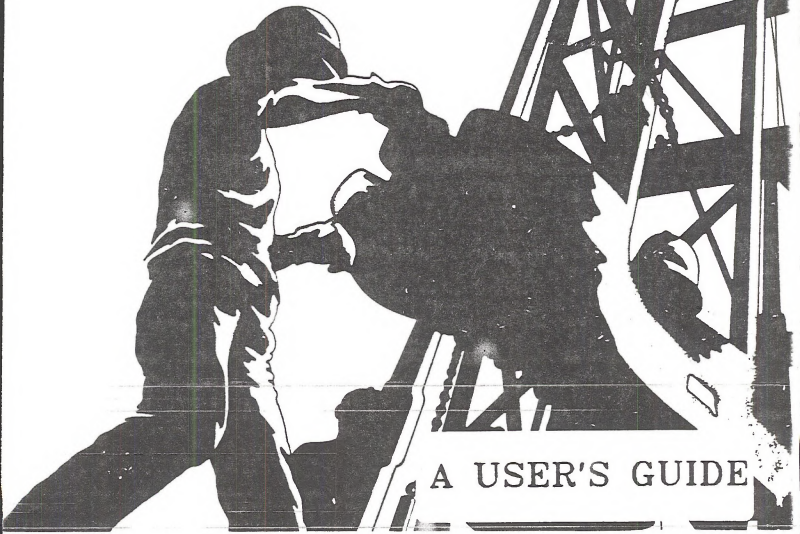
USING GIS FOR OIL AND GAS APPLICATIONS





A USER'S GUIDE

USING GIS FOR OIL AND GAS APPLICATIONS

Prepared by

Carol Wilson, Physical Scientist
Bureau of Land Management, Service Center

MARCH, 1993

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Carol Wilson, Physical Scientist
Bureau of Land Management, Service Center

INTRODUCTION

This manual has been prepared to aid field personnel in using the Bureau of Land Management's (BLM) Geographic Information System (GIS) to store, retrieve, analyze and model spatial data for use in oil and gas analyses.

GIS can be used to import data files, generate contour maps and overlay several maps to create a composite map. GIS can also be used to edit data files and generate reports.

The two GIS software packages discussed in this manual include the Map Overlay Statistical System (MOSS) and the Map Analysis and Processing System (MAPS).

If you have any GIS-questions, contact the HOTLINE at (303) 236-0990.

CREATING A WELL-LOCATION MAP

You can use GIS to process non-map data and transform the data into a positionally correct, coordinate referenced map. To create a well-location map, you can use one of the following four methods:

Method 1: DIGITIZING

You can generate a well-location map by digitizing points from a basemap using an electronic graphics tablet and a manually-operated cursor that encodes the coordinates of each point using the Automated Digitizing System (ADS). You can then use ADS2MOSS to reformat the digitized map into MOSS. (Scan digitizing may be economical in the near future.)

Method 2: XYSUBJECT

If the data are from some other data base, download the ASCII (alphanumeric text) file that contains the well identifiers and the map coordinates into your working directory. Then use the MOSS UTILITY-XYSUBJECT command (menu option #16) to reformat the

coordinate data file into a file that is in a format that MOSS can read. You can then import this file into MOSS and generate a map using the IMPORT command.

Method 3: PITOMOSS

If the data is Petroleum Information (PI) data, use the PITOMOSS program. This program will create import files and multiple attribute files.

Method 4: GGWL

Another program with ADS, called Generate Graphic Well Locations (GGWL), can generate UTM coordinate values from location footages (feet from section lines). The coordinates obtained in this manner have been proven to be considerably more accurate when compared with surveyed well locations.

Methods 2 (XYSUBJECT) and 3 (PITOMOSS) are addressed in the following sections of this manual.

SECTION ONE: USING METHOD 2 (XYSUBJECT) TO CREATE IMPORT FILES

***NOTE: If the PITOMOSS method is being used, skip this section. Go to SECTION TWO.

FACTS TO REMEMBER:

+ The subject and coordinates in the coordinate file may be in any columns as long as there is one row per well.

+ The coordinates may be in latitude/longitude (decimal degrees), feet or meters.

+ Latitude/longitude must be in decimal degrees.

  Latitude/longitude coordinate data can be converted to decimal degrees using the formula:

  decimal degrees = degrees + (minutes * 60) + (seconds * 3600)

This is a short example of a coordinate file:

```
49003201330000  44.6789 107.7654
49003202504900  43.9999 107.5555
```

XYSUBJECT asks you if the data is point or line data. It also asks if the coordinates are in decimal degrees, meters or feet. It then displays a counter line above the first line in the coordinate file as follows:

```
12345678901234567890123456789912345678901234567890
49003201330000  44.6789 107.7654
```

The program then asks you to enter the "format statement". The format is unique to your coordinate file. The format for the above example is:

```
(T25,F8.4,T17,F7.4,T6,I5)
```

This instructs the program to:

tab over to column 25 for the Y-coordinate, which is a real number with a field length of 8 spaces and 4 spaces to the right of the decimal point
tab over to column 17 for the X-coordinate, which is a real number with a field length of 7 spaces and 4 spaces to the right of the decimal point
tab over to column 6 to find the well identifier, which is an integer and has a field length of 5 spaces

The format of the output file is:

Line 1:

I5	Item number; this is a negative integer if coordinates are in latitude and longitude; right justified
10x	Ten blank spaces
30A	Subject, e.g., the well identifier
5x	Five blank spaces
I5	Number of coordinate pairs; integer; right justified

Line 2 for coordinates other than latitude/longitude:

F11.2	X-coordinate
F11.2	Y-coordinate

Line 2 for latitude/longitude coordinates:

F10.5	Longitude in decimal degrees
F10.5	Latitude in decimal degrees

SECTION TWO: USING METHOD 3 (PITOMOSS) TO CREATE IMPORT FILES

***NOTE: If XYSUBJECT method is being used, skip to SECTION THREE.

OBTAINING PI TAPES: You can obtain PI data on magnetic tapes under the BLM contract using a purchase order. You should state the format required by BLM, which is as follows:

> 9-track data, 1600 bits per inch, 80 characters per record, 4000 characters per block

You can download the data on the magnetic tapes into your working directory on the PRIME. See FIGURE 1 for an example of the PI data file. You can then convert this file into MOSS format using PITOMOSS. This PI format conversion program automatically creates import files (.IMP) and attribute files (.ATT). The .IMP files (see example in FIGURE 2) are coordinate files used with the MOSS IMPORT command to generate well location maps; the .ATT files (see examples in FIGURES 3 and 4) are multiple attribute files used in the MOSS UTILITY-ATTRIBUTE command to attach the attributes to the wells in the map. Both types of files (.IMP and .ATT) are also created for each geologic formation given in the PI data. In the case of the formation files, each file has a 3-number code and a 4-letter abbreviation for the formation. Because PRIME does not accept a file beginning with a number, it was necessary to put a '$ 'at the beginning of the file. For example:

602DKOT.IMP	becomes	$602DKOT.IMP
602DKOT.ATT	becomes	$602DKOT.ATT

RUNNING PITOMOSS: Mount the tapes on the PRIME and download into files in your working directory.

> CAUTION: The PITOMOSS program will overwrite any previously PITOMOSS-generated files. If these files are to be saved, they must be renamed.

At the PRIMOS level, enter the command 'PITOMOSS'. The program will search through all the wells in the PI data file and select only those wells within the UTM zone, county and/or latitude/longitude window that you specified. (See FIGURE 5 for a printout of the PITOMOSS command and refer to TABLE 1 for a listing of data elements that are retrieved from the PI data and stored in the .ATT files.)

The program will also generate UTM coordinate values for the location of the wells from the latitude/longitude values in the PI data. These output files are the .IMP files, which are used in the IMPORT command to generate well-location maps.

SECTION THREE: IMPORT THE .IMP FILES (FROM EITHER METHOD ABOVE)

FACTS TO REMEMBER:

+ Input file must be in MOSS import format.

+ Must enter the correct number of map subjects that are in the .IMP file to be imported. To find this number, either SLIST the .IMP file at the PRIMOS level or use the EMACS editor to find out the last sequence number in the file.

+ Must enter a scale factor: latitude/longitude files will use 100000 as a scale factor; for other projections use 100.

+ Import files generated by PITOMOSS will be in UTM coordinates.

+ Must enter the correct data type (point).

+ Other information asked for by the command is for the map header information and has no effect on the calculations.

GENERATING THE WELL-LOCATION IN MOSS: Enter MOSS and open a project. Generate the well-location map with the IMPORT command as shown in FIGURE 6. Maps for each geologic formation can also be generated using the .IMP files and the IMPORT command.

REPROJECT THE LATITUDE/LONGITUDE MAP INTO PROJECTION OF YOUR CHOICE:

If the original coordinate file was in latitude/longitude coordinates, use the PROJECTION command to reproject the imported map to another projection, such as UTM or State Plane. The coordinates for PI data are already in UTM so no reprojection is necessary unless a projection other than UTM is required, e.g., State Plane.

SECTION FOUR: CREATE A DATA FILE

***NOTE: If PITOMOSS method is being used, skip to SECTION FIVE.

The data file contains the multiple attributes (e.g., elevation) for each well location on the map. Naming convention gives the suffix .DAT or .ATT for the file. The following are examples of multiple attribute filenames:

PI.ATT $602DKOT.ATT

The multiple-attribute file may be considered a two-dimensional table composed of rows and columns. Rows in the table represent individual well locations or items:

Row 1 will correspond to Item 1 in the map;
Row 2 will correspond to Item 2 in the map;
Etc.

Columns are grouped into attribute fields and each attribute field must contain a single type of data. For example, Columns 1 through 4 may be the well identifier, columns 8 through 11 the formation elevation, and so forth. The length of an attribute field must be the same within each row.

Here is an example of a multiple attribute file for 3 wells:

```
20133  Big Horn         KB 4150  GR  4137  D&A
20250  Marathon Oil     KB 4162  GR  4151  D&A
20300  Sierra Trading   KB 4019  GR  4007  OIL
```

or it could look like this without the spaces between attribute fields:

```
20133Big Horn      KB4150GR4137D&A
20250Marathon Oil  KB4162GR4151D&A
20300Sierra TradingKB4019GR4007OIL
```

FACTS TO REMEMBER:

+ There may be up to 200 attributes per well.

+ Each attribute field must contain a single type of data.

+ Attribute fields for each well must be of the same length and type.

+ An attribute field must not be greater than 70 characters in length.

+ The order of the rows must exactly match the item number order of the well-location map. (If the data file is not in the proper order, use the UTILITY-ATTRIBUTE-RESEQUENCE command to reorder the multiple attribute file.)

There are three DATA TYPES:

CHARACTER - all the printable ASCII characters including numerics, symbols and spaces. Characters are left justified within an attribute field.

EXAMPLE: Marathon Oil

REAL - positive and negative real numbers as large as 1.8×10^{63} and numbers as small as 1.0×10^{-63}. The format for real numbers is determined by the format statement. For example, F7.4 means there are a total of 7 spaces with 4 numbers to the right of the decimal.

EXAMPLE: 44.9876

INTEGER - positive and negative integer numbers as large as 32,000. No decimal points allowed. An integer larger than 32,000 must be encoded as character data or have a scaling factor applied to the values. An integer is right justified within an attribute field.

EXAMPLE: 4162

SECTION FIVE: CREATE THE DEFINITION FILE

The definition file stores information about each attribute field within a data file, such as:

ATTRIBUTE (KEY) NAME [up to 10 characters with no spaces]
DESCRIPTION of the attribute [up to 60 characters]
DATA TYPE [integer, real or character]
FIELD WIDTH [number of spaces for the attribute; limitations according to data type]

Naming convention gives the suffix .DEF to a definition file. Here are some examples of definition filenames:

LL.DEF IPT.DEF

The definition files for the .ATT files from PITOMOSS have already been created and are listed in APPENDIX A. These files include:

```
PI.DEF   -- defines the attributes in the PI.ATT file
IPT.DEF  -- defines the attributes in the IPT.ATT file
LL.DEF   -- defines the attributes in the LL.ATT file
FORM.DEF -- defines the attributes in the FORM.ATT file
```

***** A DEFINITION FILE IS UNIQUE TO THE DATA FILE IT IS DEFINING. *****

***NOTE: If PITOMOSS method is being used, skip to SECTION SIX.

In the XYSUBJECT method, you must create a definition file before adding the attributes to the map. The definition file can be created interactively using the UTILITY-ATTDESCRIBE command. However, before using ATTDESCRIBE, determine the format of the attribute file.

For example, the first line in a file WELL.ATT might look like this:

```
20300Sierra TradingKB4019GR4007OIL
```

where,

Columns 1-5	Well identification; integer
Columns 6-19	Name of the company; character
Columns 20-21	Kelly Bushing (KB); character
Columns 22-25	KB elevation; integer
Columns 26-27	Ground (GR); character
Columns 28-31	Ground elevation; integer
Columns 32-34	Final status (D&A); character

Every space has been accounted for as ATTDESCRIBE assumes there are no spaces between attribute fields. If the file has spaces between fields, edit these spaces out of the attribute file or create the definition file and then edit the definition file.

Refer to FIGURE 7 for a printout of the ATTDESCRIBE command.

SECTION SIX: ADDING THE ATTRIBUTES TO THE MOSS MAPS

FIGURE 8 is an example of the UTILITY-ADD ATTRIBUTES command, which adds the attributes to the well-location map by using the definition file (.DEF) and the data file (.ATT). This command creates a binary file that has a mapname.AT filename. For the PITOMOSS definition files, you must use the pathname to the directory in which the PITOMOSS definition files are stored. For example:

IS>MOSS>PI.DEF

If you create a definition file with the UTILITY - ATTDESCRIBE command, you do not need a pathname if the file is in your working directory.

SECTION SEVEN: EDITING/UPDATING ATTRIBUTES

Attributes can be edited within the UTILITY-ATTRIBUTES command (Option 3-update an existing attribute) or the EDITATT command. The first command will use a data file to modify all the values for an existing attribute; the second command allow you to use cross-hairs to locate a specific well and modify, by key entry, a specific attribute or all the attributes for that point.

SECTION EIGHT: MOSS/MAPS ANALYSES

Now you can use the following commands:

DESCRIBE mapname ATTRIBUTE to view the attribute file.
SELECT, WINDOW and **PLOT** the well-location map.
LEGEND mapid LABEL to plot the subject or an attribute next to the well locations.
SELECT mapname ATTRIBUTE to select a specific attribute for plotting on the screen.
REPORT to create a table that lists the attributes you specified.
QUERY ATTRIBUTE to query a specific point on the plotted well-location map.
BSEARCH to perform complex Boolean retrievals of information from the attribute file of a map.

FIGURES 9 through 16 and TABLE 2 show various ways you can use the generated maps to analyze the data.

FIGURE 9: **PLOT**ing the map on the computer screen and using the **QUERY** command to obtain a listing of the multiple attributes for a specific well.

FIGURE 10: A structure map generated by **SELECT**ing the well-location by attribute (elevation), **GRID**ing the elevation, **CONTOUR**ing the grid, **SMOOTH** or **SCAN**ing the contour map to make a smoother looking contour map, and **PLOT**ing the map on the screen or **PENPLOT**ing the map for a cartographic output.

FIGURE 11: An isopach map showing the thickness of a formation. This was generated by **SELECT**ing the formation map by attribute (e.g., thickness), **GRID**ing, **CONTOUR**ing, **SMOOTH**ing or **SCAN**ing the contour map, and then PLOTing it on the screen or **PENPLOT**ing the map for a cartographic output.

FIGURE 12: (a) A cross section across the isopach generated by using the **PROFILE** command. (b) A 3-dimensional model of the isopach map using the **3D** command.

FIGURE 13: A map showing various possibilities for assigning symbols to the wells using the **ASSIGN** command. See the MOSS manual for tables.

FIGURES 14 through 15 and TABLE 2: Other available data can be added to the well-location map as attributes. In these examples, net feet of porous sand and average porosity were added to the multiple attributes for map analyses. FIGURE 14 shows an isopleth map of the net feet of porous sand and FIGURE 15 shows an isopleth map of the average porosity. Volume of the reservoir can be calculated as follows: (a) use the **MATH** command to multiply the net-feet-porosity grid, the average-porosity grid , and (1-.378), where .378 is the percent for connate water saturation; (b) use the **TOTAL** command to calculate acre-feet. TABLE 2 shows a listing of the volumetrics obtained by this method.

FIGURE 16 shows two gas wells, one with a drainage radius of 3839 feet and the other 6216 feet. The leases are **PLOT**ted and **SHADE**d. There may be probable drainage by the well with the larger drainage as it drains the leases where there are no wells. To create this type of map:
(a) Use the **COMPUTE** command to create a new attribute using the initial production (gas or oil) and a drainage formula for the producing formation.

Example:

```
10 ** ( ( 3.7 + ( LOG ( IP.GAS ) ) ) / 2 )
```

where IP.GAS is an attribute from the PITOMOSS program.

(b) Use the **BUFFER-ATTRIBUTE** command to buffer each well by the attribute created in step (a).
(c) **PLOT** and **SHADE** the leases. **PLOT** the landlines.

FIGURE 1. Listing of data for a sample well from a PI data file.

```
1000249003202630000000000                          0447796710854329 0447797810854540
1001049003202630000004000003 20263114028800056305611103 59MDSN 452PSPR  4650773
1002149003202630000004000TWP N  55   RNG W  97   SEC    4    066TH PRINCIPAL
101  4900320263000000400OWYO  BIG HORN IA  1100 FNL  1600 FWL     NW NE D   DO
102  4900320263000000400OMOBIL OIL                              5 ISABEL
103  4900320263000000400O 4027 KB 4016 GR                        GARLAND
104  4900320263000000400O                                      API 49-003- 20263-00
105  4900320263000000400OSPUD 01/28/1973 COMP 06/18/1973 ROTARY              OIL
106  4900320263000000400OPROJ DEPTH  4700 402DRWN  CONTR PIONEER
107  4900320263000000400OTD  4650                                  FM/TD 359MDSN
110  4900320263000000010000CSG  9 5/8 @  341 W/  700  5 1/2 @ 4630 W/  250  01 02
1400149003202630000001000FTG-330 FSL 330 FEL LOT 62
2010149003202630000002000IPP     850PD              2388W                      24HRS
2010249003202630000002000452PSPR  PERF              W/  1/FT  4112- 4149
2010349003202630000002000419TSLP  PERF              W/  1/FT  4196- 4357 GROSS
2010449003202630000002000402AMSD  PERF              W/  3/FT  4424- 4459 GROSS
2010549003202630000002000402DRWN  PERF              W/  1/FT  4536- 4554       004
2011049003202630000002000PERF  4112- 4149  4196- 4267  4282- 4292  4310- 4323
2011149003202630000002000PERF  4330- 4344  4349- 4357  4424- 4429  4455- 4459
2011249003202630000002000PERF  4536- 4554
2013049003202630000002000ACID  4112- 4149   7500GALS
2013249003202630000002000ACID  4196- 4357   4000GALS
2013449003202630000002000SWFR  4196- 4357  74000GALS  48300LBS SAND
2013649003202630000002000SWFR  4424- 4459  11000GALS   7000LBS SAND
2013849003202630000002000ACID  4424- 4459    500GALS
2023049003202630000003000SWFR  4536- 4554
2023249003202630000003000ACID  4536- 4554
2025049003202630000003000WTR
2029049003202630000003000COMMINGLED
2500149003202630000003000LOG   603FRNR    880  602MWRT   1540  602MDDT   2205
2500249003202630000003000LOG   602DKOT   2446  602LKOT   2802  553MRSN   2900
2500349003202630000003000LOG   553SNDC   3057  552GPSP   3423  509CGTR   3562
2500449003202630000003000LOG   501DNDY   4087  452PSPR   4110  419TSLP   4195
2500549003202630000003000LOG   402AMSD   4371  402DRWN   4535  359MDSN   4563
5010149003202630000004000PTS   1UO                                        7HRS
5010249003202630000004000402DRWN  PERF              W/  1/FT  4536- 4554       003
5013049003202630000004000ACID  4536- 4554    100GALS
5013149003202630000004000RATE  318/MIN                      TP 1500-2850
5013249003202630000004000WFR   4536- 4554  16000GALS  12500LBS SAND
6000149003202630000004000LOGS   344  4645 DILL         341- 4648 FD
6000249003202630000004000LOGS   341  4648 NEUT         341- 4646 PRXL
```

FIGURE 2. Partial listing of PI.IMP, which is the input file for the IMPORT command to generate a well-location map.

```
  1          26001050000000                                    1
796185.22 4583874.21
  2          26001050010000                                    1
796649.50 4583623.35
  3          26001050020000                                    1
797725.33 4586541.74
  4          26001050030000                                    1
796016.58 4587998.30
  5          26001050041000                                    1
802904.06 4601143.56
  6          26001050050000                                    1
807802.89 4605292.80
  7          26001050060000                                    1
774436.35 4610792.52
  8          26001210010000                                    1
777461.65 4605006.13
  9          26001210020000                                    1
776593.99 4595388.98
 10          26005050000000                                    1
766313.72 4602287.72
 11          26005050010000                                    1
756345.36 4607658.37
 12          26005050030000                                    1
794286.41 4618448.89
 13          26005050041000                                    1
758904.02 4617343.93
 14          26005050050000                                    1
760778.39 4598542.84
 15          26005050060000                                    1
789184.28 4593261.27
 16          26005050070000                                    1
758635.94 4587552.36
 17          26005050080000                                    1
768406.22 4587554.44
 18          26005050500000                                    1
768984.72 4617703.26
 19          26005210010000                                    1
782179.22 4607779.15
 20          26005210030000                                    1
756535.40 4607544.70
 21          26005210041000                                    1
755249.82 4607516.76
 22          26005210050000                                    1
756817.37 4598096.17
```

FIGURE 3. Partial listing of the multiple attribute file named PI.ATT. (NOTE: 2 lines below equal 1 line in actual attribute file.)

```
49 003 20132 0000  BIG HORN     56.0 N   97.0 W     19.0  NE SE SW  660 FSL  2000 FWL     D     D     60   911  D&A-OG  09/01/1969  GARLAND
MARATHON OIL                KINNEY COASTAL      62          KB  4162 GR  4151    2990   553MRSN
49 003 20133 0000  BIG HORN     52.0 N   92.0 W      4.0  NW NW SW  760 FSL   710 FWL     WF    WF    50   910  D&A-O   08/04/1969  WILDCAT
EXETOR DRILLING             SPRAGUE ETAL      4-61W         KB  4019 GR  4007    1468   452PSPR
49 003 20134 0000  BIG HORN     50.0 N   91.0 W     11.0  NW SW SE  665 FSL  1984 FEL     WF    WF    50   900  D&A     08/29/1969  WILDCAT
EL PASO OIL & GAS           MCDERMMOTT-BREENE   1           KB  4431 GR  4420    3400   419TSLP
49 003 20135 0000  BIG HORN     56.0 N   96.0 W      2.0  NW NW SE  2245 FSL 2040 FEL     D     DO    50   900  D&A     08/24/1969  WILDCAT
FALESE OIL                  USA                 1           KB  3888 GR  3878    2598   419TSLP
49 003 20136 0000  BIG HORN     51.0 N   97.0 W     29.0  SE SE NE  2270 FNL  430 FEL     D     DO    61   110  OIL     12/05/1969  GARLAND
MARATHON OIL                ROY WILLEY          3           KB  4056 GR  4045    4531   359MDSN
49 003 20137 0000  BIG HORN     49.0 N   93.0 W     24.0  NE NE SE  2505 FSL  500 FEL     WF    WF    61   110  OIL     10/06/1969  TORCHLIGHT
PAN AMERICAN PETROLEUM      UNIT               41           KB  4150 GR  4137    3775   359MDSN
49 003 20138 0000  BIG HORN     57.0 N   92.0 W     10.0  C SE SE   660 FSL   660 FEL     D     D     50   911  D&A-OG  12/03/1969  WILDCAT
PAN AMERICAN PETROLEUM      RAIRDEN UNIT        1           KB  4112 GR  4097    8200   419TNSP
49 003 20139 0000  BIG HORN     57.0 N   97.0 W     23.0  SE SW   660 FSL  1830 FWL     D     DO    60   910  D&A-O   11/28/1969  HOMESTEAD
SIERRA TRADING              FEDERAL          1-23           KB  4123 GR  4116    4262   419TSLP
49 003 20140 0000  BIG HORN     51.0 N   97.0 W     26.0  C SW SE   660 FSL   660 FWL     D     DO    61   110  OIL     10/16/1969  TORCHLIGHT
STUARCO OIL                 SHEPPERSON RANCH    1           KB  4035 GR  4025    4635   419TNSP
49 003 20141 0000  BIG HORN     51.0 N   93.0 W     24.0  SW NW SW  1780 FSL  660 FWL     D X   DO    61   110  OIL     03/26/1970  TORCHLIGHT
PAN AMERICAN PETROLEUM      UNIT               42           KB  4177 GR  4164    4070   359MDSN
49 003 20142 0000  BIG HORN     51.0 N   93.0 W     24.0  SW NW SW  1780 FSL  660 FWL     D     DO    61   1110 OIL-WO  02/10/1970  TORCHLIGHT
PAN AMERICAN PETROLEUM      TORCHLIGHT         42           KB  4178 GR  4165    4070   359MDSN
49 003 20143 0000  BIG HORN     56.0 N   93.0 W     24.0  SW SE SW  460 FSL  1780 FWL     D     DO    61   110  OIL     11/15/1969  LAMB
PAN AMERICN PETROLEUM       UNIT               43           KB  4118 GR  4105    4053   359MDSN
49 003 20144 0000  BIG HORN     54.0 N   93.0 W      2.0  NW NW SE  1989 FSL 1987 FEL     WF    WF    61   110  OIL     10/14/1969  GARLAND
STONEHENGE OIL              U S A            33-2           KB  4425 GR  4412    4356   359MDSN
49 003 20145 0000  BIG HORN     50.0 N   97.0 W     30.0  NE NW SE  2130 FSL 1897 FWL     D     D     50   901  D&A-G   12/22/1969  SPENCE DOME
MARATHON OIL                KINNEY-COASTAL     59           KB  4177 GR  4171    2190   603MDDY
49 003 20146 0000  BIG HORN     56.0 N   94.0 W      4.0  C SW SW   660 FSL   660 FWL     D     DG    60   3923 D&A     03/02/1970  MANDERSON
PAN AMERICAN PETROLEUM      UNIT                4           KB  3888 GR  3911     887   359MDSN
```

FIGURE 4A. Partial listing of IPT.ATT file, which contains the initial potential test data as multiple attributes.

```
49 003 20136 0000  OIL     12/05/1969   185 BOPD      44 MCFD  3161
49 003 20137 0000  OIL     10/06/1969   104 BOPD               1141
49 003 20140 0000  OIL     11/28/1969    70 BOPD                 90
49 003 20141 0000  OIL     10/16/1969   680 BOPD                 29
49 003 20141 0001  OIL-WO  05/26/1970    85 BOPD                359
```

FIGURE 4B Partial listing of LL.TT file, which contains the latitude and longitude coordinates for the well as multiple attributes.

```
44.50878      107.91925   49003201330000
44.31391      107.75401   49003201340000
44.85876      107.37939   49003201350000
44.80345      107.55537   49003201360000
44.37787      107.97079   49003201370000
44.22734      107.88412   49003201380000
```

FIGURE 4C. Partial listing of the formation .ATT file, which contains the multiple attributes for a specific formation.

```
49 003 20132 0000   2296  KB  4162  GR  4151   1866   108
49 003 20132 0000   2404  KB  4162  GR  4151   1758   155
49 003 20134 0000   1260  KB  4431  GR  4420   3181    82
49 003 20135 0000    711  KB  3888  GR  3878   3177   355
49 003 20136 0000   1829  KB  4056  GR  4045   2227   156
49 003 20137 0000   1118  KB  4150  GR  4137   3032   897
```

FIGURE 5. Example of running the PITOMOSS program.

```
OK, PITOMOSS

PITOMOSS WILL DELETE ALL CURRENTLY EXISTING FILES ENDING WITH
.IMP OR .ATT FROM THE CURRENT DIRECTORY.  YOU MAY CONTINUE WITH
PITOMOSS AND DELETE ANY SUCH  FILES OR YOU MAY EXIT PITOMOSS NOW.

DO YOU WANT TO EXIT PITOMOSS? (CR=N):   N

PLEASE ENTER NAME OF PI DATA FILE:      PI.DATA

ENTER UTM ZONE AS A POSITIVE NUMBER (   1 TO 20)
     OR LONGITUDE   AS A NEGATIVE NUMBER (-180 TO -1):   -108

UTM ZONE IS 13

IF YOU ONLY WANT THE WELL DATA FOR A PARTICULAR COUNTY, ENTER THE
THREE-DIGIT COUNTY CODE.  IF YOU WANT THE WELL DATA FOR ALL
COUNTIES, HIT RETURN.

ENTER MINIMUM LAT.    CR. MEANS NO LAT/LONG LIMITATIONS:

DO YOU WANT A LIST OF UNUSED RECORD TYPES? (CR=N):   N

EXECUTING...PLEASE WAIT
FIRST RECORD WITHIN SPECIFIED LAT/LONG BOUNDS FOUND AT RECORD
NUMBER 1

     1000226001050000000001000              0413548710145501
0413538310145963

          27 WELLS IN ZONE    13
          NUMBER OF PROBLEMS =     0
     **** STOP
```

TABLE 1. Listing of the multiple attributes retrieved from the PI data tape.

Header
State code
County code
API number
Offset (side track/hole change code)
Location
County name
Township, range, section
Quarter/Quarter spot location
Location footage from section line
PI latitude/longitude
Status Data
PI initial well class code
PI final well class code
PI initial/final well class code
Final well status code (numeric)
Final well status code (alpha)
Completion date
General information
Field name
Operator name
Lease name
Well number
Elevations
KB/DF elevation
Ground level elevation
Total depth of hole
Formation at total depth
Initial potential test data
Initial oil/condensate production rate
Oil/condensate production units
Initial gas production rate
Gas production units
Initial water production rate
Water production unit
Producing formation
Perforated interval
Formation data
Depth to formation
KB/DF elevation
Ground level elevation
Elevation at top of formation (elev.KB - form.depth)
Formation thickness (form.depth - form.depth of next bed)

FIGURE 6. Example run of the MOSS command IMPORT.

```
ENTER COMMAND ?  IMPORT PI.IMP

What do you wish to call the new map ?:     PI.MAP

Enter NAME of map to use as a template for the new map header or
enter CARRIAGE RETURN to start map header from scratch :

ENTER SOURCE OF MAP:       IMPORT
ENTER  CREATION DATE:      1989
ENTER  STUDYAREA NAME:     NEBRASKA
ENTER  DESCRIPTION:        WELL LOCATION MAP FROM PI DATA
ENTER  MAP VINTAGE:        1989
ENTER NUMBER OF SUBJECTS:         27
ENTER COORDINATE SCALE FACTOR:   100

        MAP PROJECTION
     # 0 PROJECTION IS GEOGRAPHIC(LON/LAT)
        COORDINATE UNITS ARE: DEGREES

DO YOU WISH TO CHANGE THE PROJECTION DESCRIPTION [N]: Y
PROJECTION(0-20) ?:  1
ELLIPSOID(0-19) ?: 0
LONGITUDE OF ANY POINT WITHIN THE UTM ZONE ?:  -101
LATITUDE OF ANY POINT WITHIN UTM ZONE   14 ?:    41
IS THIS HEADER INFORMATION CORRECT [Y]:           Y
ENTER DATATYPE
     1 = POINT        11 = (X,Y,Z) POINT
     2 = LINE         12 = (X,Y,Z) LINE
     3 = POLYGON      13 = (X,Y,Z) POLYGON
     5= SAMPLE ELEVATION POINT
: 1

EXECUTING...PLEASE WAIT
IMPORT COMPLETE FOR THE NEW MAP: PI.MAP
      27 ITEMS AND    27 SUBJECTS IN THE NEW MAP

THE INPUT FILE IS PI.IMP
DO YOU WISH TO DELETE THE INPUT FILE:  N

    **** STOP
```

FIGURE 7. Printout of a UTILITY - ATTDESCRIBE session to create a definition file.

```
ENTER COMMAND ?  UTILITY
ENTER MOSS UTILITY OPTION
       1  =  TERMINATE UTILITY SESSION   [DEFAULT]
       2  =  DATABTEST   (MOSS MAP NAMES SUPPORT)
       3  =  ATTRIBUTE   (MOSS MULTIPLE ATTRIBUTE SUPPORT)
       4  =  ATTDES      (BUILD MULTIPLE ATTRIBUTE DEFINITION FILE)
       5  =  SUB2AT      (SUBJECT TO MULTIPLE ATTRIBUTE INPUT)
       6  =  APROJ       (MOSS MAP NAMES PROJECTION ASSIGNMENT)
       7  =  BROWZ       (MOSS MAP NAMES HEADER LISTING)
       8  =  PLOT.LEGEND (BUILD PLOTTER LEGEND FILE)
       9  =  MAKE.LOGO   (BUILD PLOTTER LOGO FILE)
      10  =  SUBEDIT     (MAP SUBJECT EDIT PROGRAM)
      11  =  SET.LEVEL   (BUILD POLYCELL TRANSLATION FILE)
      12  =  TRANSFORM   (TRANSFORM COORDINATES TO A PROJECTION)
      13  =  QUAD        (MAKE A QUAD MAP IN IMPORT/EXPORT FORMAT)
      14  =  DLG3        (USGS DLG ASCII TO MOSS)
      15  =  MAPIDX      (MAKE INDEX MAP OF PROJECT IN IMPORT/EXPORT FORMAT)
      16  =  XYSUBJECT   (REFORMAT POINT DATA TO MOSS)
      17  =  F_DRIVE     (SYMBOL MANAGEMENT)
      18  =  ATT2SUB     (ATTRIBUTE TO SUBJECT)
      19  =  CTOG        (CONTOUR TO GRID)
      : 4
          *** ATTRIBUTE DESCRIPTION PROGRAM ***

What do you wish to call the Definition File?  SAMPLE.DEF
Provide a ten character description for "KEY"   1 ? DRILLHOLE
Provide a 60 character description of this "KEY":  DRILL HOLE IDENTIFICATION
The field type of this "KEY" is
     1 - Integer  2 - Floating point  3 - Character
    Select:  3
What is the field length of this "KEY"?   10

       Attribute:       1    Key:      DRILLHOLE
       Description:  DRILL HOLE IDENTIFICATION
       Type:      CHARACTER     Length:      10
       Edit options:  [0] - Proceed to next attribute (#   2)
                      1  - Edit attribute KEY
                      2  - Edit attribute DESCRIPTION
                      3  - Edit field TYPE and LENGTH
                      4  - QUIT
                      5  - ABORT
    Select: 0

Provide a ten character description for "KEY"   2:    OPERATOR
Provide a 60 character description of this "KEY":    NAME OF OPERATOR
The field type of this "KEY" is
    1 - Integer  2 - Floating point  3 - Character
    Select: 3
What is the field length of this "KEY"?   20

    Attribute:       2    Key:      OPERATOR
    Description:  NAME OF OPERATOR
    Type:      CHARACTER     Length:      20
    Edit options:  [0] - Proceed to next attribute (#   3)
                   1  - Edit attribute KEY
                   2  - Edit attribute DESCRIPTION
                   3  - Edit field TYPE and LENGTH
                   4  - QUIT
                   5  - ABORT
    Select: 4

*** STOP ****
```

FIGURE 8. Sample run of the MOSS command UTILITY to add attributes (PI.ATT, IPT.ATT and LL.ATT) to the well-location map.

```
ENTER COMMAND ? UTILITY
ENTER MOSS UTILITY OPTION
          1  =  TERMINATE UTILITY SESSION   [DEFAULT]
          2  =  DATABTEST   (MOSS MAP NAMES SUPPORT)
          3  =  ATTRIBUTE   (MOSS MULTIPLE ATTRIBUTE SUPPORT)
          4  =  ATTDES      (BUILD MULTIPLE ATTRIBUTE DEFINITION FILE)
          5  =  SUB2AT      (SUBJECT TO MULTIPLE ATTRIBUTE INPUT)
          6  =  APROJ       (MOSS MAP NAMES PROJECTION ASSIGNMENT)
          7  =  BROWZ       (MOSS MAP NAMES HEADER LISTING)
          8  =  PLOT.LEGEND (BUILD PLOTTER LEGEND FILE)
          9  =  MAKE.LOGO   (BUILD PLOTTER LOGO FILE)
         10  =  SUBEDIT     (MAP SUBJECT EDIT PROGRAM)
         11  =  SET.LEVEL   (BUILD POLYCELL TRANSLATION FILE)
         12  =  TRANSFORM   (TRANSFORM COORDINATES TO A PROJECTION)
         13  =  QUAD        (MAKE A QUAD MAP IN IMPORT/EXPORT FORMAT)
         14  =  DLG3        (USGS DLG ASCII TO MOSS)
         15  =  MAPIDX      (MAKE INDEX MAP OF PROJECT IN IMPORT/EXPORT FORMAT)
         16  =  XYSUBJECT   (REFORMAT POINT DATA TO MOSS)
         17  =  F_DRIVE     (SYMBOL MANAGEMENT)
         18  =  ATT2SUB     (ATTRIBUTE TO SUBJECT)
         19  =  CTOG        (CONTOUR TO GRID)
        : 3

PLEASE ENTER MAP NAME:   PI.MAP

THE NUMBER OF ATTRIBUTES IS     0
THE NUMBER OF ITEMS IS         27
PLEASE ENTER DESIRED OPTION
          1  =  EXIT   [DEFAULT]
          2  =  ADD A NEW ATTRIBUTE
          3  =  UPDATE AN EXISTING ATTRIBUTE
          4  =  CHANGE/DELETE KEY OR DESCRIPTOR
          5  =  LIST ATTRIBUTE FIELDS
          6  =  SEARCH AN ATTRIBUTE FIELD
          7  =  RESEQUENCE INPUT DATA FILE
          8  =  DELETE THE ATTRIBUTE FILE
        : 2

WILL YOU BE USING A DEFINITION FILE?:           YES
ENTER THE NAME OF THE ATTRIBUTE DEFINITION FILE:  IS>MOSS>PI.DEF
PLEASE ENTER THE NAME OF THE INPUT DATA FILE:    PI.ATT

THE NUMBER OF ATTRIBUTES IS    28
THE NUMBER OF ITEMS IS         27

PLEASE ENTER DESIRED OPTION
          1  =  EXIT   [DEFAULT]
          2  =  ADD A NEW ATTRIBUTE
          3  =  UPDATE AN EXISTING ATTRIBUTE
          4  =  CHANGE/DELETE KEY OR DESCRIPTOR
          5  =  LIST ATTRIBUTE FIELDS
          6  =  SEARCH AN ATTRIBUTE FIELD
          7  =  RESEQUENCE INPUT DATA FILE
          8  =  DELETE THE ATTRIBUTE FILE
        : 2

WILL YOU BE USING A DEFINITION FILE?:           YES
ENTER THE NAME OF THE ATTRIBUTE DEFINITION FILE:  IS>MOSS>IPT.DEF
PLEASE ENTER THE NAME OF THE INPUT DATA FILE:    IPT.ATT

THE NUMBER OF ATTRIBUTES IS    50
THE NUMBER OF ITEMS IS         27

PLEASE ENTER DESIRED OPTION
```

```
          1  =  EXIT    [DEFAULT]
          2  =  ADD A NEW ATTRIBUTE
          3  =  UPDATE AN EXISTING ATTRIBUTE
          4  =  CHANGE/DELETE KEY OR DESCRIPTOR
          5  =  LIST ATTRIBUTE FIELDS
          6  =  SEARCH AN ATTRIBUTE FIELD
          7  =  RESEQUENCE INPUT DATA FILE
          8  =  DELETE THE ATTRIBUTE FILE
        : 2

WILL YOU BE USING A DEFINITION FILE?:          YES
ENTER THE NAME OF THE ATTRIBUTE DEFINITION FILE: IS>MOSS>LL.DEF
PLEASE ENTER THE NAME OF THE INPUT DATA FILE:   LL.ATT

THE NUMBER OF ATTRIBUTES IS    52
THE NUMBER OF ITEMS IS         27

PLEASE ENTER DESIRED OPTION
          1  =  EXIT    [DEFAULT]
          2  =  ADD A NEW ATTRIBUTE
          3  =  UPDATE AN EXISTING ATTRIBUTE
          4  =  CHANGE/DELETE KEY OR DESCRIPTOR
          5  =  LIST ATTRIBUTE FIELDS
          6  =  SEARCH AN ATTRIBUTE FIELD
          7  =  RESEQUENCE INPUT DATA FILE
          8  =  DELETE THE ATTRIBUTE FILE
        : 1
        **** STOP

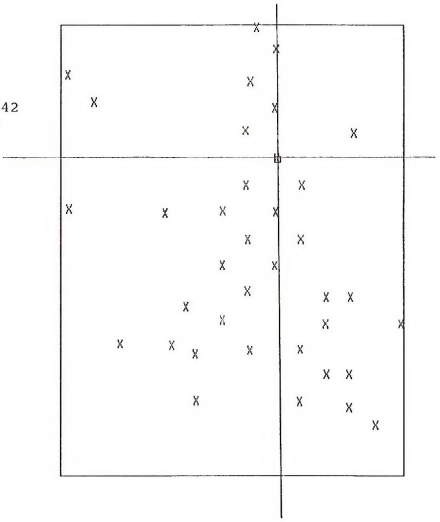
       MOSS UTILITY SESSION COMPLETED
```

FIGURE 9. Example shows the use of the QUERY command and crosshairs to list the attributes for a specific well.

```
ENTER COMMAND ?  QUERY 1

POINT TO ITEM, SPACE will REPEAT
ITEM HAS FOLLOWING CHARACTERISTICS
SUBJECT   = 49003202660000
MAP NAME  = OGMAP     ITEM NUMBER =   142
ENTER   0-FOR ALL   1- 52-FOR SPECIFIC
   : 0

STATE            49
CTY.CODE          3
API.NUM       20266
OFFSET            0
COUNTY       BIG HORN
TOWNSHIP         53.0
NS               N
RANGE            96.0
EW               W
SECTION          32.0
SPOT.LOC     SW SE SE
LOC.FTG      624 FSL   686 FEL
F.STATUS     D&A
COMPL.DATE   01/26/1973
FIELD        WILDCAT
OPERATOR     CHAMPLIN PETROLEUM
LEASE        CHAMPLIN ETAL
WELL.NUM     1
RD           KB
ELEV.KB        4465
TSGR         GR
ELEV.GR        4454
TOT.DEPTH     10641
FORM.TD      603CODY
IP.OIL            0
IP.GAS
```



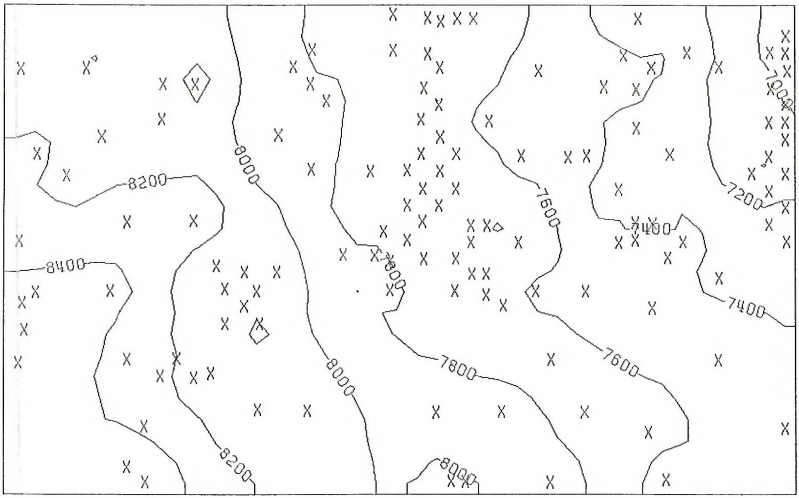


FIGURE 10. Structure map of a selected formation using the GRID, CONTOUR, and AUTOLABEL commands.

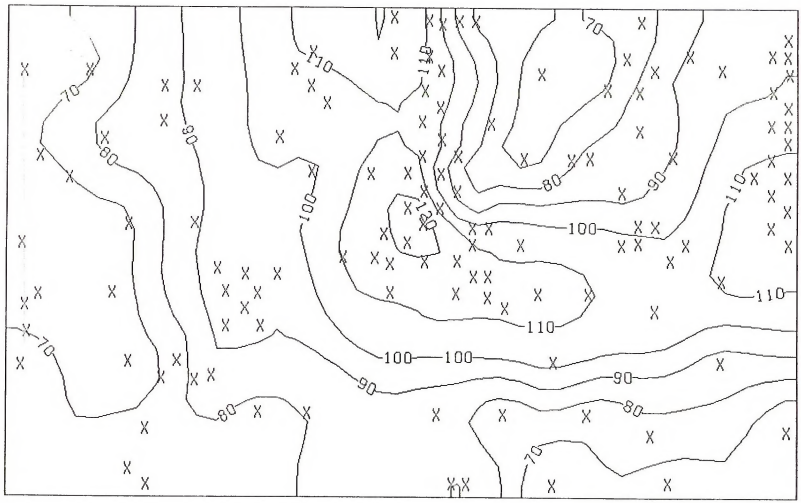
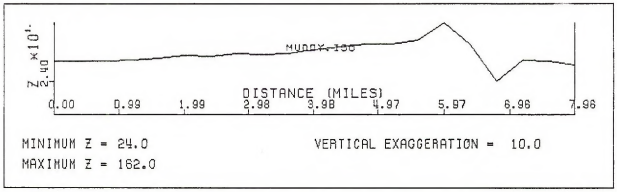


FIGURE 11. Isopach map of a selected formation using the GRID, CONTOUR, and AUTOLABEL commands.

FIGURE 12. (A) NW-SE cross section across the isopach map using the PROFILE command. (B) A 3-dimensional model of the structure map using the 3-D command.



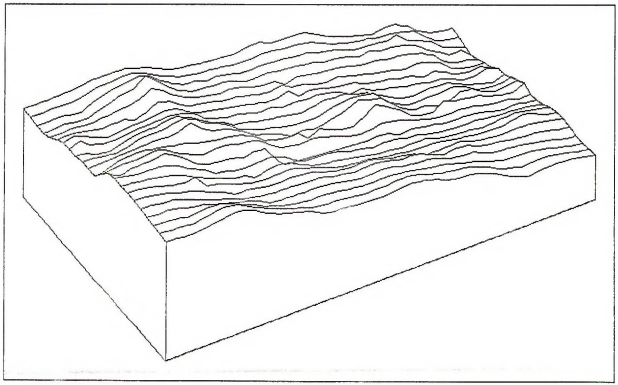
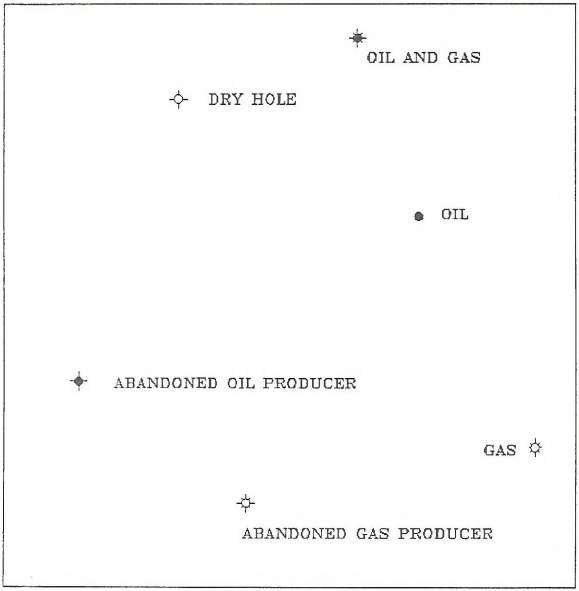


FIGURE 13. Map showing well locations plotted with a variety of symbols available in MOSS using the ASSIGN command.



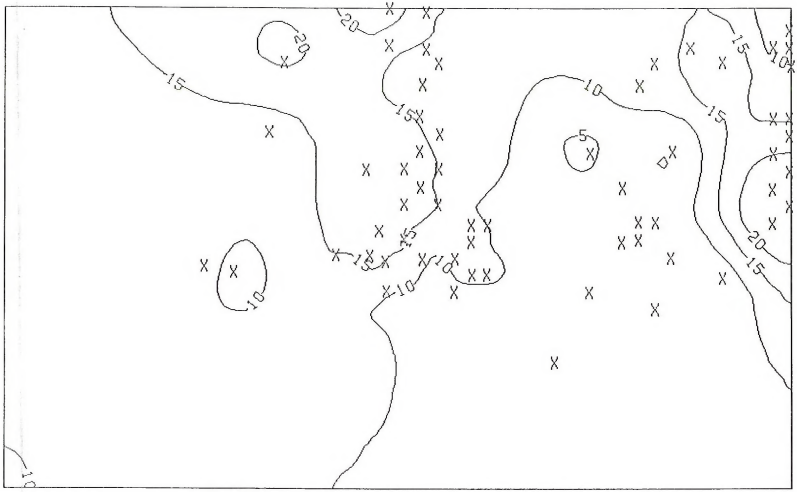


FIGURE 14. Isopleth map showing the net feet of porous sand.

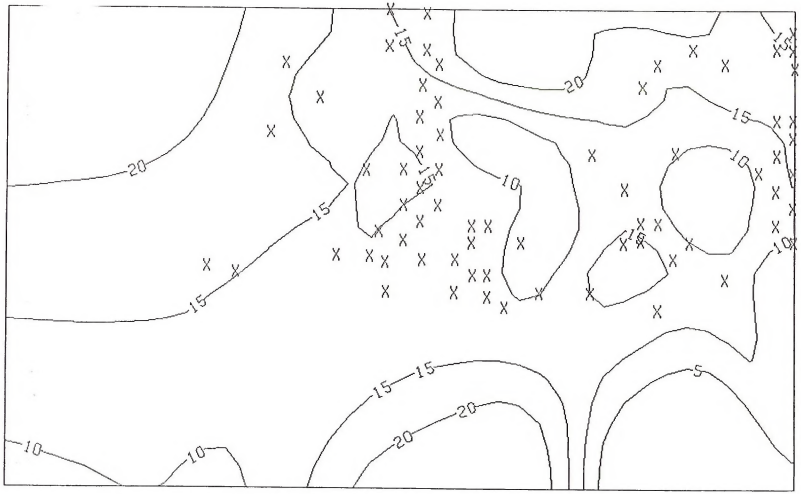


FIGURE 15. Isopleth map showing the average porosity.

TABLE 2. Listing of volume of the reservoir, using 37.8 percent for connate water saturation. Volume was calculated by first using the MATH command to multiply the net-feet-porosity grid, the average-porosity grid, and (1-.378) and then using the TOTAL command to calculate the volume of the reservoir.

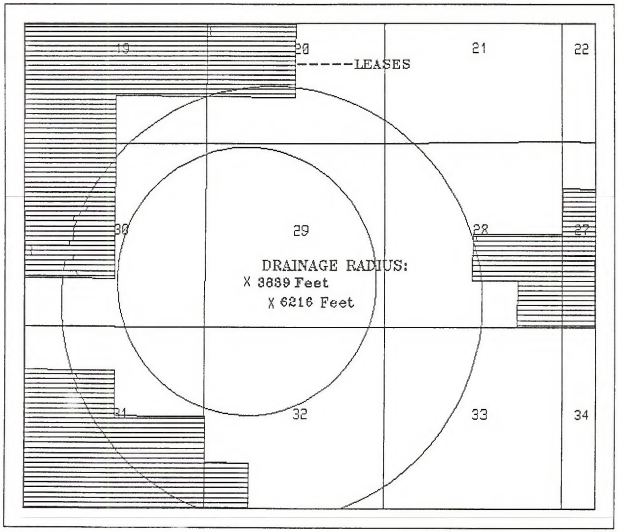
'TOTAL' REPORT PAGE 1

MAPNAME	FACTOR	CELL SIZE
RESERVOIR	1.000	61.776
BY LEASE.POL		

SUBJECTS	TOTAL	FREQUENCY	ACRES	AC-FT	AVG.THK.
LEASE	101264	1050	64865	6261923.490	96.538

(BACKGROUND ACRES = 0.)

FIGURE 16. Map showing two gas wells, each bufffered to drainage radius based on an attribute value.



APPENDIX A

DEFINITION FILES FOR PITOMOSS ATTRIBUTE FILES

A-1. LISTING OF THE PI.DEF DEFINITION FILE AND THE PI CARD LOCATIONS.

Definition File:	PI Card Location:
STATE STATE CODE 1 (T1,I2) 1	Card 10002 - Cols. 6-7
CTY.CODE COUNTY CODE 1 (T4,I3) 1	Card 10002 - Cols. 8-10
API.NUM AMERICAN PETROLEUM INSTITUTE NUMBER 1 (T8,I5) 1	Card 10002 - Cols. 11-15
OFFSET SIDE TRACK/HOLE CHANGE CODE 1 (T14,I4) 1	Card 10002 - Cols. 16-19
COUNTY COUNTY 3 8 (T20,8A) 1	Card 101 - Cols. 32-38
TOWNSHIP TOWNSHIP 2 (T30,F6.1) 1	Card 10021 - Cols. 31-36
NS NORTH OR SOUTH TOWNSHIP LABEL 3 1 (T37,1A) 1	Card 10021 - Col. 30
RANGE RANGE 2 (T40,F6.1) 1	Card 10021 - Cols. 43-48
EW EAST OR WEST RANGE LABEL 3 1 (T47,1A) 1	Card 10021 - Col. 42
SECTION SECTION 2 (T50,F6.1) 1	Card 10021 - Cols. 54-59
SPOT.LOC QUARTER/QUARTER SPOT LOCATION 3 8 (T58,8A) 1	Card 101 - Cols. 64-71
LOC.FTG LOCATION/FOOTAGE FROM SECTION LINE 3 20 (T68,20A)	Card 101 - Cols. 43-62

```
1
I.WELL.CLS                          Card 101 - Cols. 73-75
PI INITIAL WELL CLASS CODE
3
3
(T90,3A)
1
F.WELL.CLS                          Card 101 - Cols. 77-79
PI FINAL WELL CLASS CODE
3
3
(T95,3A)
1
W.CLASS                             Card 10010 - Cols. 50-51
PI INITIAL/FINAL WELL CLASS CODE
3
2
(T100,2A)
1
NUM.STATUS                          Card 10010 - Cols. 52-55
FINAL WELL STATUS CODE (NUMERIC)
1
(T104,I4)
1
F.STATUS                            Card 10010 - Cols. 74-79
FINAL WELL STATUS CODE (ALPHA)
3
6
(T110,6A)
1
COMPL.DATE                          Card 105 - Cols. 47-56
COMPLETION DATE
3
10
(T118,10A)
1
FIELD                               Card 103 - Cols. 63-79
FIELD NAME
3
17
(T130,17A)
1
OPERATOR                            Card 102/XX - Cols. 26-48
OPERATOR NAME
3
24
(T149,24A)
1
LEASE                               Card 102/XX - Cols. 61-79
LEASE NAME
3
19
(T175,19A)
1
WELL.NUM                            Card 102/XX - Cols. 50-59
WELL NUMBER
3
10
(T196,10A)
1
RD                                  Card 103 - Cols. 32-33
KB OR DF LABEL
3
2
(T208,2A)
1
ELEV.KB                             Card 103 - Cols. 26-30
KB/DF ELEVATION
1
(T211,I5)
1
TSGR                                Card 103 - Cols. 40-41
TS OR GR LABEL
```

```
3
2
(T218,2A)
T1
1
ELEV.GR                              Card 103 - Cols. 34-38
GROUND LEVEL ELEVATION
1
(T221,I5)
1
TOT.DEPTH                            Card 10010 - Cols. 72-76
TOTAL DEPTH OF HOLE
1
(T228,I5)
1
FORM.TD                              Card 10010 - Cols. 56-63
PI FORMATION CODE AT TOTAL DEPTH
3
8
(T235,8A)
2
```

A-2. LISTING OF THE IPT.DEF DEFINITION FILE AND THE PI CARD LOCATIONS.

DEFINITION FILE:	PI CARD LOCATION:

```
IP.OIL                                  Card 2XX/01 - Cols. 30-33
INITIAL OIL/CONDENSATE PRODUCTION RATE
1
(T40,I4)
1
OIL.UNITS                               Card 2XX/01 - Cols. 34-37
OIL/CONDENSATE PRODUCTION UNITS
3
4
(T45,4A)
1
IP.GAS                                  Card 2XX/01 - Cols. 39-45
INITIAL GAS PRODUCTION RATE
2
(T51,F7.0)
1
GAS.UNITS                               Card 2XX/01 - Cols. 46-49
GAS PRODUCTION UNITS
3
4
(T59,4A)
1
IP.WATER                                Card 2XX/01 - Cols. 51-54
INITIAL WATER PRODUCTION RATE
1
(T65,I4)
1
WATER.UNIT                              Card 2XX/01 - Cols. 55-56
WATER PRODUCTION UNIT
3
2
(T71,2A)
1
PROD.FORM1                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 1
3
8
(T75,8A)
1
PERFS1                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 1
3
11
(T85,11A)
1
PROD.FORM2                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 2
3
8
(T97,8A)
1
PERFS2                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 2
3
11
(T107,11A)
1
PROD.FORM3                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 3
3
8
(T119,8A)
1
PERFS3                                  Card 2XX/02-09 - Cols. 56-69
```

```
PERFORATED INTERVAL 3
3
11
(T129,11A)
1
PROD.FORM4                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 4
3
8
(T141,8A)
1
PERFS4                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 4
3
11
(T151,11A)
1
PROD.FORM5                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 5
3
8
(T163,8A)
1
PERFS5                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 5
3
11
(T173,11A)
1
PROD.FORM6                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 6
3
8
(T185,8A)
1
PERFS6                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 6
3
11
(T195,11A)
1
PROD.FORM7                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 7
3
8
(T207,8A)
1
PERFS7                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 7
3
11
(T217,11A)
1
PROD.FORM8                              Card 2XX/02-09 - Cols. 26-33
PRODUCING FORMATION 8
3
8
(T229,8A)
1
PERFS8                                  Card 2XX/02-09 - Cols. 56-69
PERFORATED INTERVAL 8
3
11
(T239,11A)
2
```

A-3. LISTING OF THE LL.DEF DEFINITION FILE AND THE PI CARD LOCATIONS.

DEFINITION FILE:	PI CARD LOCATION:
LAT	Card 10002 - Cols. 64-71
LATITUDE	
3	
12	
(T1,12A)	
1	
LONG	Card 10002 - Cols. 72-79
LONGITUDE	
3	
12	
(T15,12A)	
2	

A-4. LISTING OF THE FORM.DEF DEFINITION FILE AND THE PI CARD LOCATIONS.

DEFINITION FILE: PI CARD LOCATION:

```
STATE                                   Card 10002 - Cols. 6-7
STATE CODE
1
(T1,I2)
1
CTY.CODE                                Card 10002 - Cols. 8-10
COUNTY CODE
1
(T4,I3)
1
API.NUM                                 Card 10002  - Cols. 11-15
AMERICAN PETROLEUM INSTITUTE NUMBER
1
(T8,I5)
1
OFFSET                                  Card 10002 - Cols. 16-19
SIDE TRACK/HOLE CHANGE CODE
1
(T14,I4)
1
FORM.DEPTH                              Card 250/XX - Cols. 41-45
DEPTH TO FORMATION                          Cols. 57-61, 73-77
1
(T20,I5)
1
RD                                      Card 103 - Cols. 32-33
KB OR DF LABEL
3
2
(T27,2A)
1
ELEV.KB                                 Card 103 - Cols. 26-30
KB/DF ELEVATION
1
(T30,I5)
1
TSGR                                    Card 103 - Cols. 40-41
TS OR GR LABEL
3
2
(T37,2A)
1
ELEV.GR                                 Card 103 - Cols. 34-38
GROUND LEVEL ELEVATION
1
(T40,I5)
1
ELEV.TOP
ELEVATION AT TOP OF FORMATION (ELEV.KB - FORM.DEPTH)
1
(T46,I6)
1
THICKNESS
FORMATION THICKNESS (FORM.DEPTH - FORM.DEPTH OF NEXT BED)
1
(T54,I5)
2
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